

WHAT IS CLAIMED IS:

1. A rectifying circuit comprising:
a rectifying diode having a breakdown voltage and a first forward
5 voltage, and configured to rectify a first AC voltage to output a first DC
voltage; and

a protection diode circuit having a plurality of constant reverse
voltage diodes and electrically connected to the rectifying diode in parallel
therein, said plurality of constant reverse voltage diodes being electrically
10 connected to each other in series, each of said plurality of constant
reverse voltage diodes having a breakdown voltage and a second forward
voltage,

wherein a sum of said breakdown voltages of the plurality of
constant reverse voltage diodes is lower than the breakdown voltage of the
15 rectifying diode, and a sum of said second forward voltages of the constant
reverse voltage diodes is higher than the first forward voltage of the
rectifying diode.

2. A rectifying circuit according to claim 1, wherein said plurality
20 of constant reverse voltage diodes are plurality of Zener diodes.

3. A rectifying circuit according to claim 1, wherein said plurality
of constant reverse voltage diodes and the rectifying diode are integrated
with each other in a common module or common chip.

25 4. A rectifying circuit according to claim 1, wherein said first AC

voltage is a voltage that is induced in a secondary winding of a transformer of a DC-DC converter, said secondary winding being electrically connected to the rectifying diode.

5 5. A rectifying circuit according to claim 4, wherein said DC-DC converter is configured to supply the first DC voltage which is lower than a second DC voltage, to convert the second DC voltage into a second AC voltage, and to supply the second AC voltage to a primary winding of the transformer, so that the first AC voltage is induced in the secondary
10 winding of the transformer.

6. A rectifying circuit according to claim 1, wherein said plurality of constant reverse voltage diodes are plurality of avalanche diodes.

15 7. A rectifying circuit comprising:
a rectifying diode having a breakdown voltage and a first forward voltage, said rectifying diode being configured to rectify an AC voltage; and
a protection diode circuit having a protection diode and a constant reverse voltage diode and electrically connected in parallel to the rectifying
20 diode, said protection diode having a breakdown voltage and a second forward voltage and being reversely connected to the rectifying diode, said constant reverse voltage diode having a breakdown voltage and a third forward voltage and electrically connected reversely to the protection diode in series,

25 wherein a sum of said second forward voltage of the protection diode and the breakdown voltage of the constant reverse voltage diode is

lower than the breakdown voltage of the rectifying diode, and a sum of said breakdown voltage of the protection diode and the third forward voltage of the constant reverse voltage diode is higher than the first forward voltage of the rectifying diode.

5

8. A rectifying circuit according to claim 7, wherein said constant reverse voltage diode is a Zener diode.

9. A rectifying circuit according to claim 7, wherein said constant reverse voltage diode, protection diode, and rectifying diode are integrated with each other in a common module or common chip.

10

10. A rectifying circuit according to claim 7, wherein said first AC voltage is a voltage that is induced in a secondary winding of a transformer of a DC-DC converter, said secondary winding being electrically connected to the rectifying diode.

15

11. A rectifying circuit according to claim 10, wherein said DC-DC converter is configured to supply the first DC voltage which is lower than a second DC voltage, to convert the second DC voltage into a second AC voltage, and to supply the second AC voltage to a primary winding of the transformer, so that the first AC voltage is induced in the secondary winding of the transformer.

20

12. A rectifying circuit according to claim 7, wherein said constant reverse voltage diode is an avalanche diode.

25

13. A rectifying circuit comprising:

a synchronous rectifying MOS transistor having a breakdown voltage and an intrinsic diode with a first forward voltage, said
5 synchronous rectifying MOS transistor being configured to synchronously rectify an AC voltage; and

a protection diode circuit having a plurality of constant reverse voltage diodes and electrically connected to the synchronous rectifying MOS transistor in parallel thereto, said plurality of constant reverse
10 voltage diodes being electrically connected to each other in series, each of said plurality of constant reverse voltage diodes having a breakdown voltage and a second forward voltage,

wherein a sum of said breakdown voltages of the plurality of constant reverse voltage diodes is lower than the breakdown voltage of the
15 synchronous rectifying MOS transistor, and a sum of said second forward voltages is higher than the first forward voltage of the intrinsic diode of the synchronous rectifying MOS transistor.

14. A rectifying circuit according to claim 13, wherein said
20 plurality of constant reverse voltage diodes are the plurality of Zener diodes.

15. A rectifying circuit according to claim 13, wherein said
plurality of constant reverse voltage diodes and the rectifying MOS
25 transistor are integrated with each other in a common module or common chip.

16. A rectifying circuit according to claim 13, wherein said first AC voltage is a voltage that is induced in a secondary winding of a transformer of a DC-DC converter, said secondary winding being
5 electrically connected to the synchronous rectifying MOS transistor.

17. A rectifying circuit according to claim 16, wherein said DC-DC converter is configured to supply the first DC voltage which is lower than a second DC voltage, to convert the second DC voltage into a
10 second AC voltage, and to supply the second AC voltage to a primary winding of the transformer, so that the first AC voltage is induced in the secondary winding of the transformer.

18. A rectifying circuit according to claim 13, wherein said
15 plurality of constant reverse voltage diodes are plurality of avalanche diodes.

19. A rectifying circuit comprising:
a synchronous rectifying MOS transistor having a breakdown
20 voltage and an intrinsic diode with a first forward voltage, said synchronous rectifying MOS transistor being configured to synchronously rectify an AC voltage; and

a protection diode circuit having a protection diode and a constant reverse voltage diode and electrically connected in parallel to the
25 synchronous rectifying MOS transistor, said protection diode having a breakdown voltage and a second forward voltage and being reversely

connected with respect to the intrinsic diode of the synchronous rectifying MOS transistor, said constant reverse voltage diode having a breakdown voltage and a third forward voltage, and electrically connected reversely to the protection diode in series,

- 5 wherein a sum of said second forward voltage of the protection diode and the breakdown voltage of the constant reverse voltage diode is lower than the breakdown voltage of the synchronous rectifying MOS transistor, and a sum of said breakdown voltage of the protection diode and said third forward voltage of the constant reverse voltage diode is
10 higher than the first forward voltage of the intrinsic diode.

20. A rectifying circuit according to claim 19, wherein said constant reverse voltage diode is a Zener diode.

- 15 21. A rectifying circuit according to claim 19, wherein said constant reverse voltage diode and the MOS transistor are integrated with each other in a common module or common chip.

22. A rectifying circuit according to claim 19, wherein said first
20 AC voltage is a voltage that is induced in a secondary winding of a transformer of a DC-DC converter, said secondary winding being electrically connected to the MOS transistor.

23. A rectifying circuit according to claim 22, wherein said
25 DC-DC converter is configured to supply the first DC voltage which is lower than a second DC voltage, to convert the second DC voltage into a

BEST AVAILABLE COPY

second AC voltage, and to supply the second AC voltage to a primary winding of the transformer, so that the first AC voltage is induced in the secondary winding of the transformer.

- 5 24. A rectifying circuit according to claim 19, wherein said constant reverse voltage diode is an avalanche diode.